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Nureki

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(54) **THERMAL ACTIVATION APPARATUS FOR A HEAT-SENSITIVE ADHESIVE SHEET**

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(73) Assignee: **Seiko Instruments Inc.** (JP)

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(51) **Int. Cl.**
B41J 2/38 (2006.01)
B41J 2/315 (2006.01)

(52) **U.S. Cl.** **347/187**; 347/171

(58) **Field of Classification Search** 347/171, 347/187

See application file for complete search history.

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(57) **ABSTRACT**

A thermal activation apparatus has a casing which houses a drawing roller that draws a heat-sensitive adhesive sheet through an insertion port and transports the sheet through the casing. A cutter unit cuts the sheet to a predetermined length, a thermal activation unit thermally activates a heat-sensitive adhesive layer of the cut sheet, and a discharge roller discharges the thermally-activated sheet through a discharge port. A CPU controls the cutter unit and the thermal activation unit based on various factors so that the heat-sensitive adhesive layer is thermally activated only when needed.

9 Claims, 4 Drawing Sheets

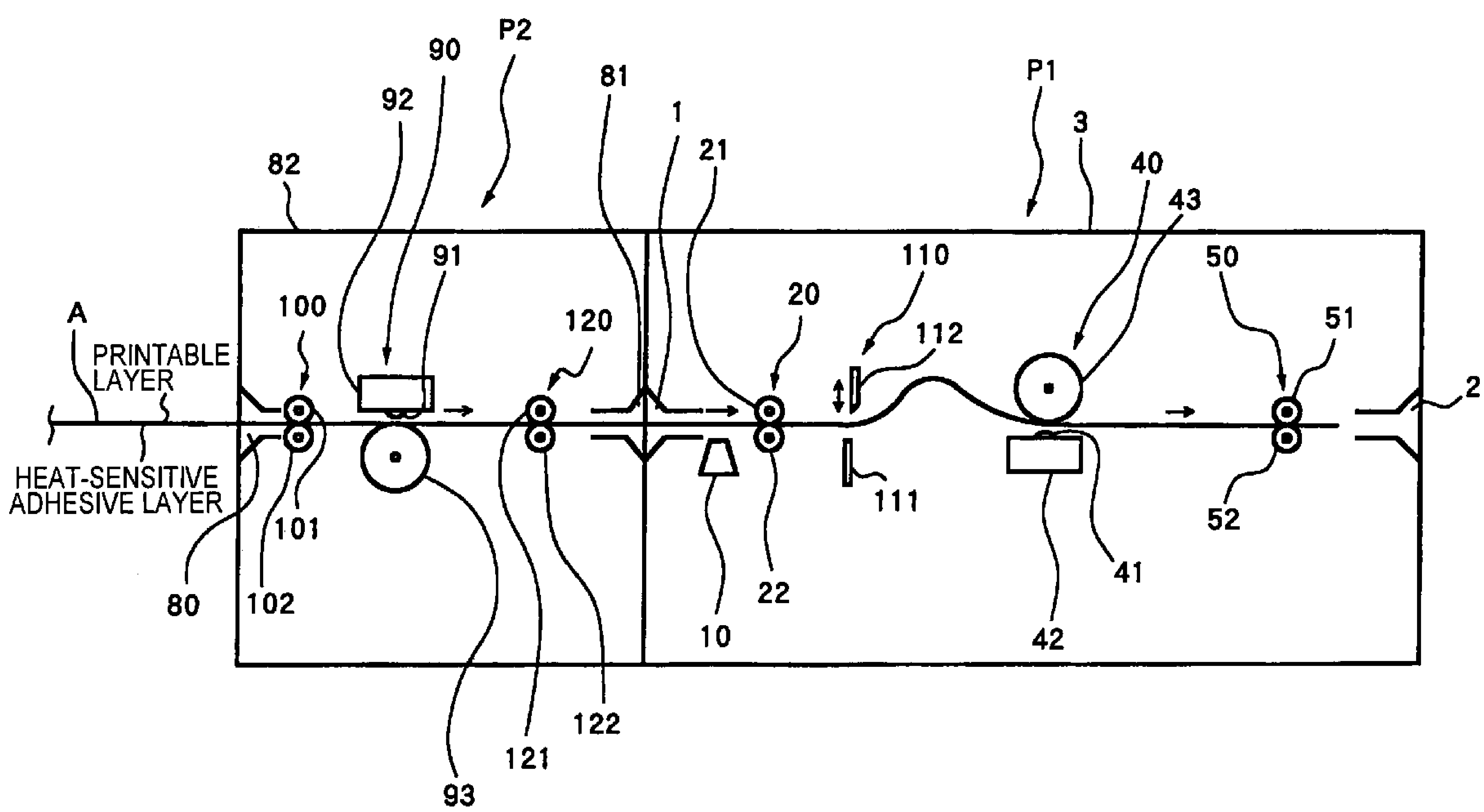


FIG. 1

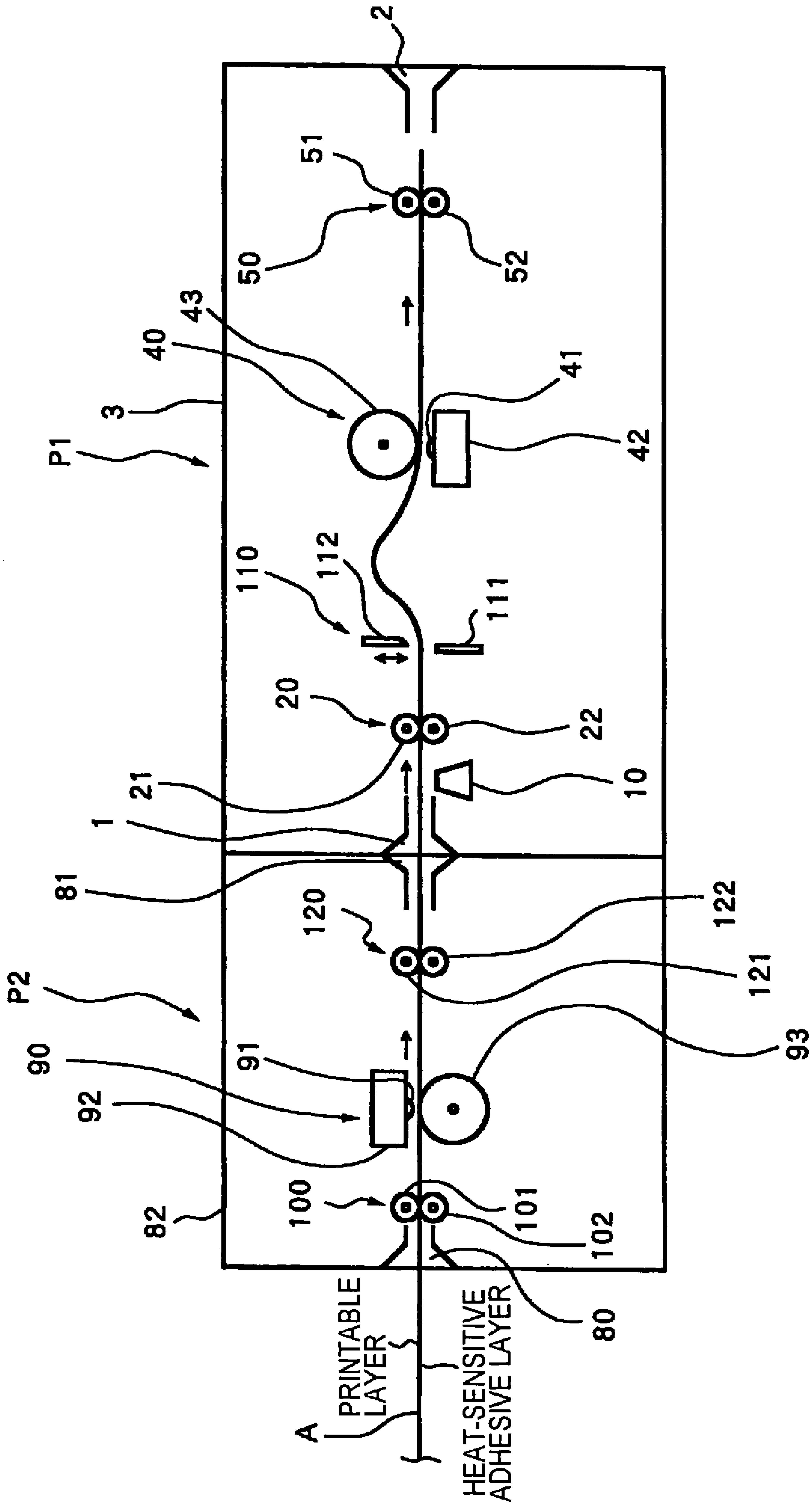

2
51
50
52
40
43
41
3
P1
42
110
112
111
20
22
21
10
1
81
120
122
121
P2
90
91
93
92
100
101
102
82
80
A
PRINTABLE LAYER
HEAT-SENSITIVE ADHESIVE LAYER

FIG. 2

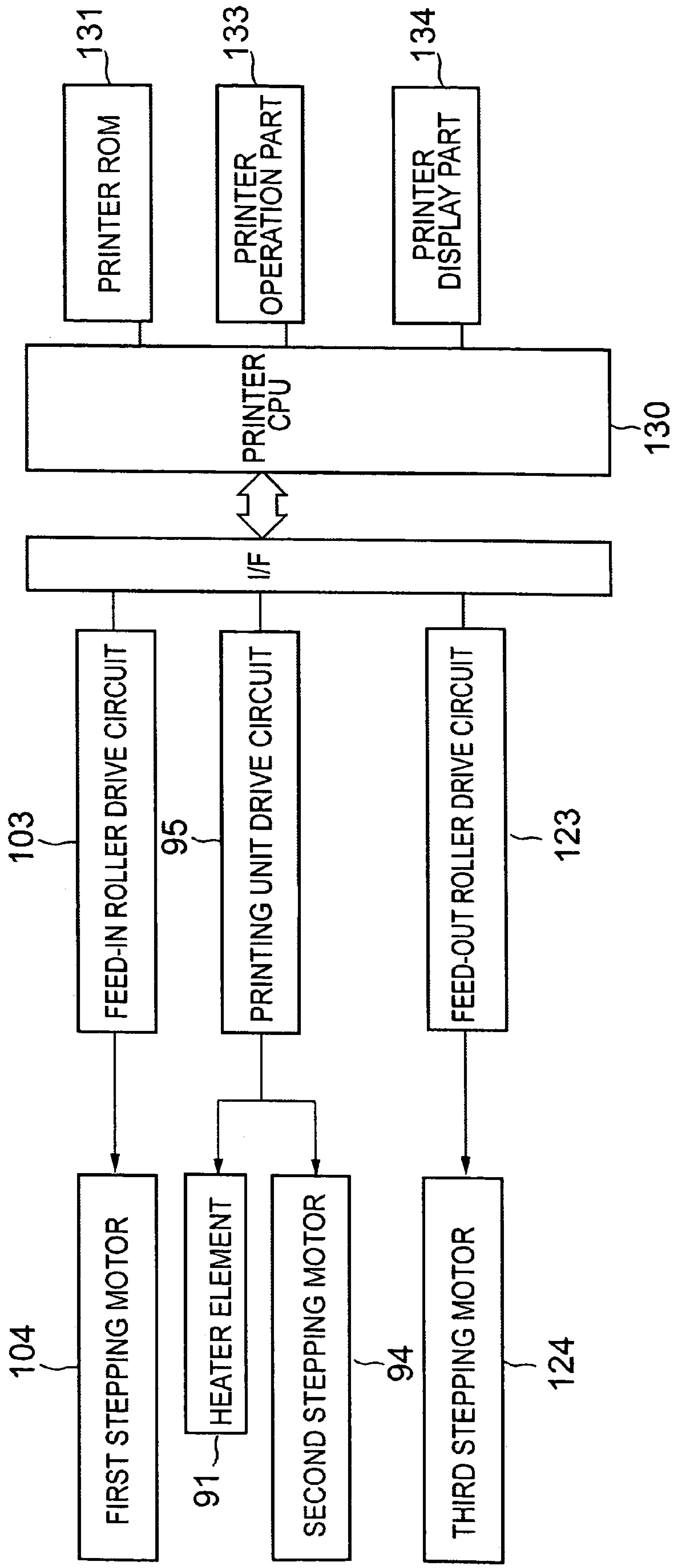

PRINTER ROM
131
PRINTER OPERATION PART
133
PRINTER DISPLAY PART
134
PRINTER CPU
130
I/F
FEED-IN ROLLER DRIVE CIRCUIT
103
PRINTING UNIT DRIVE CIRCUIT
95
FEED-OUT ROLLER DRIVE CIRCUIT
123
FIRST STEPPING MOTOR
104
HEATER ELEMENT
91
SECOND STEPPING MOTOR
94
THIRD STEPPING MOTOR
124

FIG. 3

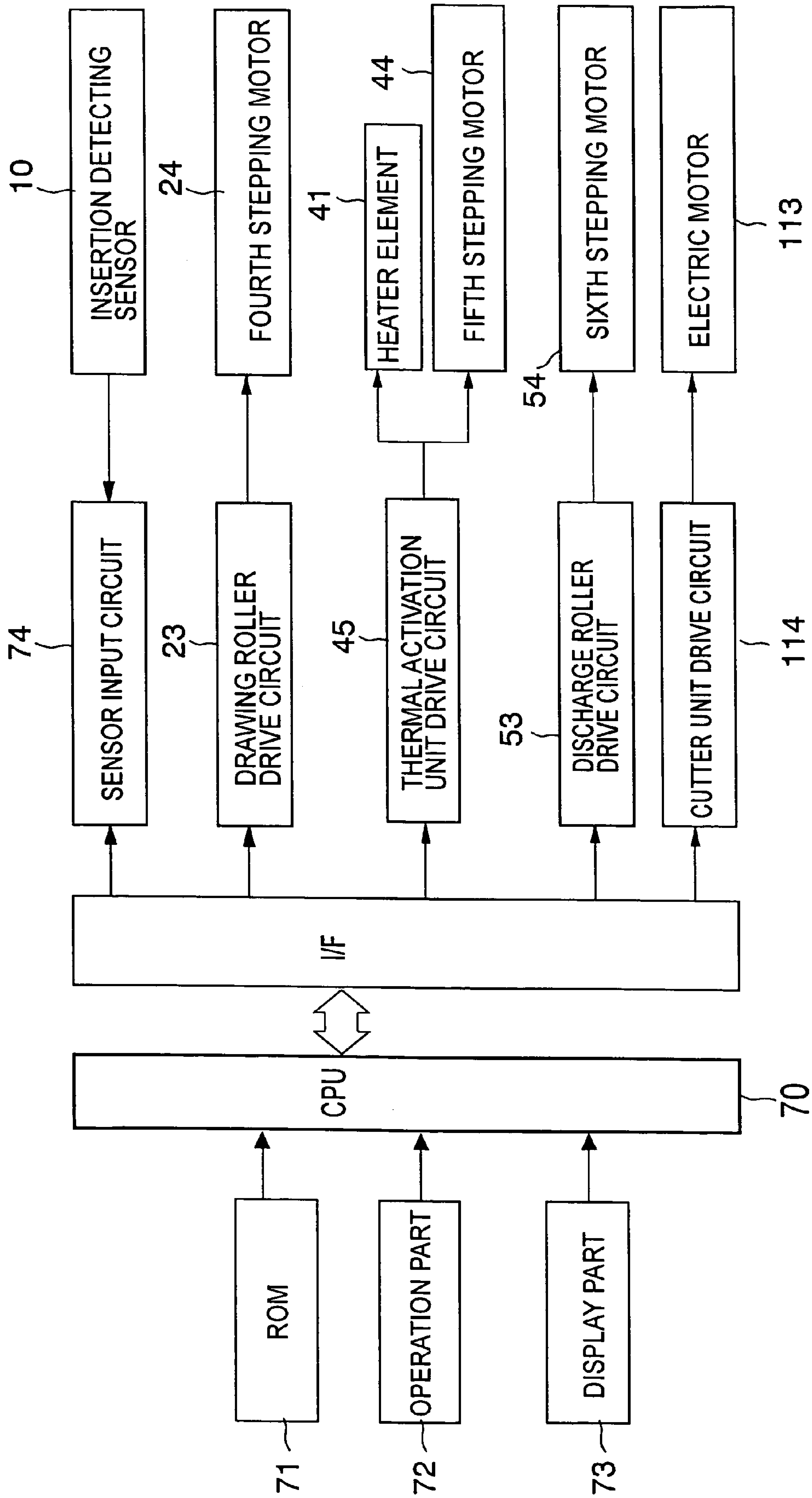
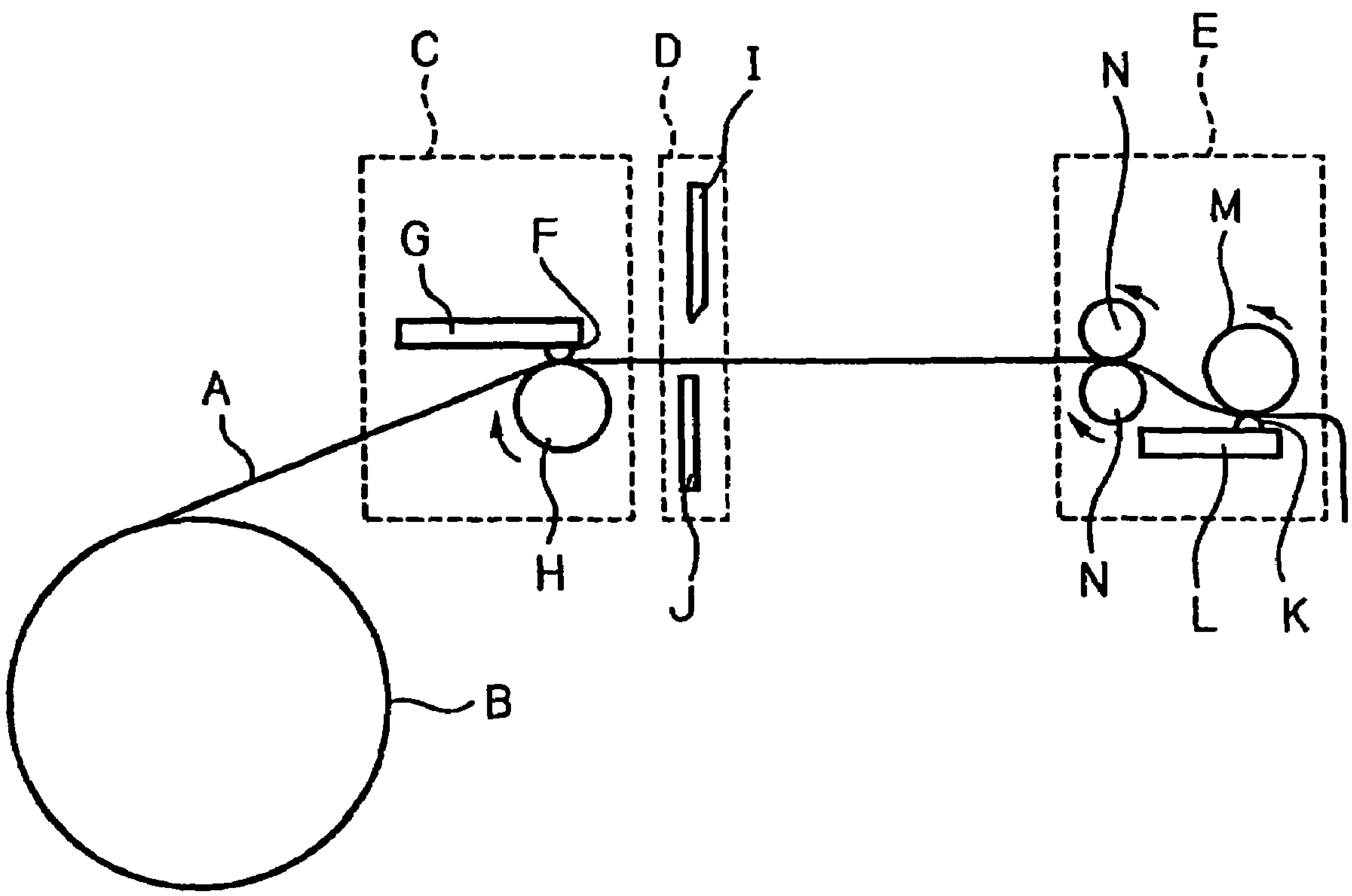

INSERTION DETECTING SENSOR
10
FOURTH STEPPING MOTOR
24
HEATER ELEMENT
41
FIFTH STEPPING MOTOR
44
SIXTH STEPPING MOTOR
54
ELECTRIC MOTOR
113
SENSOR INPUT CIRCUIT
74
DRAWING ROLLER DRIVE CIRCUIT
23
THERMAL ACTIVATION UNIT DRIVE CIRCUIT
45
DISCHARGE ROLLER DRIVE CIRCUIT
53
CUTTER UNIT DRIVE CIRCUIT
114
I/F
CPU
70
ROM
71
OPERATION PART
72
DISPLAY PART
73

FIG. 4 PRIOR ART



THERMAL ACTIVATION APPARATUS FOR A HEAT-SENSITIVE ADHESIVE SHEET

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a thermal activation apparatus for a heat-sensitive adhesive sheet, which heats and thermally activates a heat-sensitive adhesive layer formed on one surface of a sheet-like base material.

2. Description of the Prior Art

In recent years, a heat-sensitive adhesive sheet has been used as a sheet put on a product. The heat-sensitive adhesive sheet is a printing medium in which a sheet base material has a heat-sensitive adhesive layer having no adherence in ordinary circumstances but exhibiting its adherence under heating on one surface, and has a printable layer on the other surface. For example, the sheet has been widely used as a POS sheet for food products, distribution sheets, delivery sheets, medical sheets, baggage tags, and labels on bottles and cans.

Proposed as a printer for a heat-sensitive adhesive sheet for effecting printing on such heat-sensitive adhesive sheets is a printer having a thermal activation mechanism where a heat-sensitive adhesive layer of a heat-sensitive adhesive label is heated in contact with a head having plural resistor elements (heater elements) provided on a ceramic substrate as a heat source like a thermal head used for a printing head for a thermal printer (see Patent Document JP 11-079152 A for example).

Referring now to FIG. **4**, a general structure for a conventional printer for a heat-sensitive adhesive sheet is described. The printer for a heat-sensitive adhesive sheet of FIG. **4** is composed of a roll containing unit B for holding a rolled, tape-like heat-sensitive adhesive sheet (heat-sensitive adhesive label A), a printing unit C for effecting printing on the heat-sensitive adhesive label A, a cutter unit D for cutting the heat-sensitive adhesive sheet A into a label with a predetermined length, and a thermal activation unit E as a thermal activation apparatus for thermally activating a heat-sensitive adhesive layer of the heat-sensitive adhesive label A.

The printing unit C is constructed of a printing thermal head G having plural heater elements F composed of plural, relatively small resistor elements arranged in a width direction so as to enable dot printing, a printing platen roller H brought into pressure contact with the printing thermal head G (heater elements F), and the like. In FIG. **4**, the printing platen roller H is rotated clockwise to transport the heat-sensitive adhesive label A to the right.

The cutter unit D is adapted to cut the heat-sensitive adhesive label A, which has undergone printing with the printing unit C, to an appropriate length and is composed of a movable blade I operated by a drive source (not shown) such as an electric motor with a stationary blade J opposing the movable blade I, and the like.

The thermal activation unit E is constructed of a thermal-activation thermal head L as heating means having a heater element K, a thermal activation platen roller M as transporting means for transporting the heat-sensitive adhesive label A, a drawing roller N for drawing the heat-sensitive adhesive label A fed from the printing unit C side in between the thermal-activation thermal head L (heater element K) and the thermal activation platen roller M, and the like. In FIG. **4**, the thermal activation platen roller M is rotated in a direction (counterclockwise direction) opposite to the rotation direction of the printing platen roller H to transport the heat-sensitive adhesive label A in a predetermined direction (to the right).

SUMMARY OF THE INVENTION

The conventional printer for a heat-sensitive adhesive sheet has a printing unit for effecting printing on a printable layer of a heat-sensitive adhesive sheet and a thermal activation unit for thermally activating a heat-sensitive adhesive layer, the unit being integrated, and thus involves the following problems.

(1) It is impossible to selectively perform only one of printing on a printable layer and thermal activation of a heat-sensitive adhesive layer. Accordingly, it is impossible to previously perform printing only on the printable layer and then optionally thermally activate the heat-sensitive adhesive layer to put it onto an object. In other words, so-called "collective labeling" cannot be conducted.

(2) Any general-purpose printer not exclusive to the heat-sensitive adhesive sheet is also capable of printing on the printable layer. However, as discussed above, the conventional printer for the heat-sensitive adhesive sheet has such a structure that printing and thermal activation are performed in succession. Therefore, it is impossible to conduct only thermal activation of the printed heat-sensitive adhesive sheet by using the general-purpose printer. In the end, when using the heat-sensitive adhesive sheet, an additional printer exclusive to a heat-sensitive adhesive sheet is necessary.

An object of the present invention is to provide a thermal activation apparatus for a heat-sensitive adhesive sheet, which is capable of thermally activating a heat-sensitive adhesive layer of the heat-sensitive adhesive sheet as needed and is detachably attachable to a printer as needed.

In order to attain the above-mentioned object, a thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention includes at least an insertion port through which the heat-sensitive adhesive sheet including a sheet-like base material is inserted with the sheet-like base material having a printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface, a first transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port, a second transporting means for receiving the heat-sensitive adhesive sheet from the first transporting means and transporting the heat-sensitive adhesive sheet, thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the second transporting means, cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length, a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged, and controlling means for controlling the first transporting means and the second transporting means such that the heat-sensitive adhesive sheet temporarily sags between the cutting means and the thermal activation means. Consequently, the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet can be thermally activated as needed. Also, it is possible to cut other portion of the heat-sensitive adhesive sheet concurrently with the thermal activation of a sagging portion of the sheet.

Further, a thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention includes at least an insertion port through which the printed heat-sensitive adhesive sheet is inserted after being discharged from a printer for effecting printing on a printable layer of the heat-sensitive adhesive sheet including a sheet-like base material having the printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface, transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port, thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the transporting means, a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged, and controlling means for controlling at least one of the transporting means and the thermal activation means according to sheet feeding pitch signals output from the printer, whereby the apparatus enables, by utilizing the signals output from the printer, an operation in synchronization with or in consideration of a printing rate of the printer.

Further, the thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention further includes cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length based on information transmitted from the printer, and controlling means for calculating a time Tw from when the printer starts a printing operation till when the thermal activation means starts a thermal activation operation and a time Tt necessary for a leading edge of the heat-sensitive adhesive sheet printed by the printer to reach the thermal activation means and, when a relationship of $Tw \geqq Tt$ is established, allowing the thermal activation means to start the thermal activation operation after the elapse of the time Tw from when the printer starts the printing operation and, when a relationship of $Tw < Tt$ is established, allowing the thermal activation means to start the thermal activation operation at a point in time when the leading edge of the heat-sensitive adhesive sheet reaches the thermal activation means. Consequently, it is possible to reduce a time lag between the end of the printing operation and the start of the cutting operation as much as possible. As a result, an overall throughput is significantly improved rather than a case where the printing operation, the cutting operation, and the thermal activation operation are independently performed.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:

FIG. **1** is a structural view schematically showing a thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention.

FIG. **2** is a block diagram showing a control system and a drive system of a printer P**2** of FIG. **1**.

FIG. **3** is a block diagram showing a control system and a drive system of a thermal activation apparatus P**1** of FIG. **1**.

FIG. **4** is a structural view schematically showing a conventional printer for a heat-sensitive adhesive sheet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a thermal activation apparatus for a heat-sensitive adhesive sheet according to an embodiment of the present invention will be described in detail with reference to the drawings. FIG. **1** is a schematic diagram showing how a thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention (hereinafter, referred to as "thermal activation apparatus P**1**") is mounted to a printer P**2** capable of printing on a printable layer of a heat-sensitive adhesive sheet A, the sheet A including a sheet base material having the printable layer on its front surface and a heat-sensitive adhesive layer on its rear surface. FIG. **2** is a block diagram showing a control system and a drive system of the printer P**2**. FIG. **3** is a block diagram showing a control system and a drive system of the thermal activation apparatus P**1**. Note that the printer P**2** and the thermal activation apparatus P**1** are connected to each other in a detachably attachable form by any detaching/attaching means and are individually operable as explained below. The detaching/attaching means may be provided to either the printer P**2** or the thermal activation apparatus P**1** or to both of them.

The printer P**2** shown in FIG. **1** includes a printer casing **82** having a printer insertion port **80** through which the heat-sensitive adhesive sheet A is inserted and a printer discharge port **81** through which the heat-sensitive adhesive sheet A is discharged. Provided inside the printer casing **82** are a printing unit **90** for effecting printing on the printable layer of the heat-sensitive adhesive sheet A, a feed-in roller **100** for transporting the heat-sensitive adhesive sheet A inserted through the printer insertion port **80** to the printing unit **90**, and a feed-out roller **120** for discharging to the outside the printed heat-sensitive adhesive sheet A through the printer discharge port **81**. Although omitted from FIG. **1**, a control system and a drive system of FIG. **2** are also provided inside the printer casing **82**. The control system of FIG. **2** is constructed of a printer CPU **130** as controlling means for effecting control over the printing unit **90**, the feed-in roller **100**, the feed-out roller **120**, etc., a printer ROM **131** storing a control program etc. which the printer CPU **130** runs, a printer operation part **133** for inputting various types of necessary data or calling up the input data, a printer display part **134** for displaying the input or output data or other data, and the like. Note that, the drive system of FIG. **2** is described later.

Here, there is no particular limitation on the heat-sensitive adhesive sheet A on which the printer P**2** of FIG. **1** can perform printing. For example, such a sheet includes a heat-sensitive adhesive label as disclosed in Patent Document 1 above with the label including a sheet base material having a heat insulating layer and a heat-sensitive color-developing layer (printable layer) on its front surface and a heat-sensitive adhesive layer on its rear surface, the heat-sensitive adhesive layer being formed by applying and drying a heat-sensitive adhesive. A typical heat-sensitive adhesive mainly contains a thermoplastic resin, a solid plastic resin, or the like. However, there is no particular limitation on a composition of the heat-sensitive adhesive as well. The heat-sensitive adhesive sheet also includes a heat-sensitive adhesive label where a protective layer or colored print layer (preprinted layer) is formed on the surface of the heat-sensitive color-developing layer.

The feed-in roller **100** of FIG. **1** is composed of an upper feed-in roller **101** (rotating roller) placed on an upper side across a transport path for the heat-sensitive adhesive sheet A and a lower feed-in roller **102** (rotated roller) placed on a lower side across the same. The upper feed-in roller **101** is connected to a first stepping motor **104** via an unillustrated transmission mechanism, the stepping motor being controlled by the printer CPU **130** through a feed-in roller drive circuit **103** of FIG. **2**. On the other hand, the lower feed-in roller **102** is mounted rotatably about a rotation axis. Once the first stepping motor **104** is driven according to a drive signal output from the feed-in roller drive circuit **103** in response to an instruction from the printer CPU **130** of FIG. **2**, the upper feed-in roller **101** of FIG. **1** starts rotating counterclockwise. Along with the rotation, the unprinted heat-sensitive adhesive sheet A inserted through the printer insertion port **80** is drawn in between the upper feed-in roller **101** and the lower feed-in roller **102** and transported to the printing unit **90**. At this point, the lower feed-in roller **102** is rotated along with the movement of the heat-sensitive adhesive sheet A while bringing the heat-sensitive adhesive sheet A into pressure contact with the upper feed-in roller **101**. Of course, the lower feed-in roller **102** may be connected to the first stepping motor **104** to serve as a rotating roller, whereas the upper feed-in roller **101** may serve as a rotated roller.

The printing unit **90** of FIG. **1** is constructed of a printing thermal head **92** having plural heater elements **91** composed of plural, relatively small resistor elements arranged in a width direction so as to enable dot printing, a printing platen roller **93** for transporting the heat-sensitive adhesive sheet A while bringing the printable layer of the sheet in pressure contact with the printing thermal head **92**, a second stepping motor **94** of FIG. **2** as a drive source for the printing platen roller **93**, a printing unit drive circuit **95** for driving the printing thermal head **92** (heater element **91**) and the second stepping motor **94**, an unillustrated transmission mechanism for transmitting a torque of the second stepping motor **94** to the printing platen roller **93**, and the like.

The printing thermal head **92** of FIG. **1** has the same structure as those of thermal heads used as printing heads for known thermal printers. That is, a protective layer made of crystallized glass is formed on the surface of each of plural heater elements (heating resistor elements) formed on a ceramic substrate by using a thin-film or thick-film formation technique. Therefore, a detailed description thereof is omitted here.

In the printing unit **90** thus structured, once the second stepping motor **94** is driven according to a drive signal output from the printing unit drive circuit **95** in response to an instruction from the printer controlling part **130** of FIG. **2**, its torque is transmitted to the printing platen roller **93** via the transmission mechanism. As a result, the printing platen roller **93** starts rotating clockwise. The unprinted heat-sensitive adhesive sheet A transported by the feed-in roller **100** is thereby drawn in between the printing thermal head **92** and the printing platen roller **93** and is fed toward the feed-out roller **120** side while its printable layer comes into pressure contact with the heater element **91**. Also, the printing thermal head **92** (heater element **91**) starts printing (heating) in accordance with a drive signal output from the printing unit drive circuit **95** concurrently with or after the elapse of a predetermined time from when the printing platen roller **93** starts rotating. Then, the head effects printing on the printable layer.

The printing unit **90** desirably includes pressure means for pressing the printing thermal head **92** against the printing platen roller **93**, such as a coil spring or a plate spring, and adjusting means for adjusting a pressing force of the pressure means. The rotation axis of the printing platen roller **93** is desirably kept in parallel to an arrangement direction of the heater elements **91** with a view to uniformly pressing the printable layer over the width direction against the printing thermal head **92** (heater element **91**).

The feed-out roller **120** of FIG. **1** is composed of an upper feed-out roller **121** (rotating roller) placed on an upper side across a transport path for the heat-sensitive adhesive sheet A and a lower feed-out roller **122** (rotated roller) placed on a lower side across the same. The upper feed-out roller **121** is connected to a third stepping motor **124** via an unillustrated transmission mechanism, the stepping motor being controlled by the printer CPU **130** through a feed-out roller drive circuit **123** of FIG. **2**. On the other hand, the lower feed-out roller **122** is mounted rotatably about a rotation axis. Once the third stepping motor **124** is driven according to a drive signal output from the feed-out roller drive circuit **123** in response to an instruction from the printer CPU **130** of FIG. **2**, the upper feed-out roller **121** starts rotating counterclockwise. Along with the rotation, the printed heat-sensitive adhesive sheet A that has passed through the printing unit **90** is drawn in between the upper feed-out roller **121** and the lower feed-out roller **122** and discharged through the printer discharge port **81** to the outside. At this point, the lower feed-out roller **122** is rotated along with the movement of the heat-sensitive adhesive sheet A while bringing the heat-sensitive adhesive sheet A into pressure contact with the upper feed-out roller **121**. Of course, the lower feed-out roller **122** may be connected to the third stepping motor **124** to serve as a rotating roller, whereas the upper feed-out roller **121** may serve as a rotated roller.

The printed heat-sensitive adhesive sheet A thus discharged through the printer discharge port **81** of the printer P2 of FIG. **1** is fed into the thermal activation apparatus P1 in the figure, in which the heat-sensitive adhesive layer is thermally activated.

The thermal activation apparatus P1 of FIG. **1** includes a casing **3** having an insertion port **1** through which the heat-sensitive adhesive sheet A discharged through the printer discharge port **81** is fed and a discharge port **2** through which the heat-sensitive adhesive sheet A having the thermally activated heat-sensitive adhesive layer is discharged. Arranged along the transport path for the heat-sensitive adhesive sheet A inside the casing **3** are an insertion detecting sensor **10**, a drawing roller **20**, a cutter unit **110**, a thermal activation unit **40**, and a discharge roller **50**. Although omitted from FIG. **1**, a control system and a drive system of FIG. **3** are also provided inside the casing **3**. The control system of FIG. **3** is constructed of a CPU **70** as controlling means for effecting control over the insertion detecting sensor **10**, the drawing roller **20**, the cutter unit **110**, the thermal activation unit **40**, the discharge roller **50**, etc., a ROM **71** storing a control program etc. which the printer CPU **70** runs, an operation part **72** for inputting various types of necessary data or calling up the input data, a display part **73** for displaying the input or output data or other data, and the like. Note that, the drive system of FIG. **3** is described later.

Here, there is no particular limitation on the heat-sensitive adhesive sheet A whose heat-sensitive adhesive layer is thermally activated by the thermal activation apparatus P1. For example, such a sheet includes a heat-sensitive adhesive label as disclosed in Patent Document 1 above, in which a label base material has a heat insulating layer and a heat-sensitive color-developing layer (printable layer) on its front surface and a heat-sensitive adhesive layer on its rear surface, the heat-sensitive adhesive layer being formed by applying and drying a heat-sensitive adhesive. Note that a typical heat-sensitive adhesive mainly contains a thermoplastic resin, a solid plastic resin, or the like. However, there is no particular limitation on a composition of the heat-sensitive adhesive as well. The heat-sensitive adhesive sheet A also includes a heat-sensitive adhesive label where a protective layer or colored print layer (preprinted layer) is formed on the surface of the heat-sensitive color-developing layer.

The insertion port **1** of FIG. **1** is open on a side surface of the casing **3** having a substantially rectangular parallelepiped shape. The discharge port **2** is open on the other side surface of the casing **3**, the surface opposing the side surface where the insertion port **1** is open. Note that the heat-sensitive adhesive sheet A can be manually inserted through the insertion port **1** as well. Also, there is no limitation on positions where the insertion port **1** and the discharge port **2** are open; the ports may be both open anywhere but the above-mentioned positions.

The insertion detecting sensor **10** of FIG. **1** is an optical sensor and is arranged closer to the drawing roller **20** than the insertion port **1** is positioned, by a predetermined distance. The insertion detecting sensor **10** optically detects the leading edge of the heat-sensitive adhesive sheet A inserted in the insertion port **1** by a predetermined length or longer and outputs a sensor signal (insertion detection signal) to a sensor input circuit **74** of FIG. **3**. The input insertion detection signal is output from the sensor input circuit **74** to the CPU **70** via an interface (I/F **75**). Note that the insertion detecting sensor may be a mechanical sensor or other sensor.

The drawing roller **20** of FIG. **1** is composed of an upper drawing roller **21** (rotating roller) placed on an upper side across a transport path for the heat-sensitive adhesive sheet A and a lower drawing roller **22** (rotated roller) placed on a lower side across the same. The upper drawing roller **21** is connected to a fourth stepping motor **24** via an unillustrated transmission mechanism, the stepping motor being controlled by the CPU **70** through a drawing roller drive circuit **23** of FIG. **3**. On the other hand, the lower drawing roller **22** is mounted rotatably about a rotation axis. Once the fourth stepping motor **24** is driven according to a drive signal output from the drawing roller drive circuit **23** in response to an instruction from the CPU **70** of FIG. **3**, the upper drawing roller **21** of FIG. **1** starts rotating counterclockwise. Along with the rotation, the heat-sensitive adhesive sheet A inserted through the insertion port **1** is drawn in between the upper drawing roller **21** and the lower drawing roller **22** and transported to the cutter unit **110** side. At this point, the lower drawing roller **22** is rotated along with the movement of the heat-sensitive adhesive sheet A while bringing the heat-sensitive adhesive sheet A into pressure contact with the upper drawing roller **21**. Of course, the lower drawing roller **22** may be connected to the fourth stepping motor **24** to serve as a rotating roller, whereas the upper drawing roller **21** may serve as a rotated roller.

The cutter unit **110** of FIG. **1** is constructed of a stationary blade **111** placed on a lower side across the transport path for the heat-sensitive adhesive sheet A, a movable blade **112** approaching and leaving the stationary blade **111** in a reciprocable fashion, which is placed on an upper side across the same, an electric motor **113** of FIG. **3** as a drive source for the movable blade **112**, a cutter unit drive circuit **114**, and the like. In the cutter unit **110** with such a structure, when the electric motor **113** is driven by the cutter unit drive circuit **114** in response to an instruction from the CPU **70** of FIG. **3**, the movable blade **112** moves down to approach the stationary blade **111** to thereby cut the heat-sensitive adhesive sheet A on the transport path and then moves upward to its original position.

The thermal activation unit **40** of FIG. **1** is composed of a thermal-activation thermal head **42** having plural heater elements **41** for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet A, a thermal activation platen roller **43** for transporting the heat-sensitive adhesive sheet A while bringing the heat-sensitive adhesive layer into pressure contact with the thermal-activation thermal head **42**, a fifth stepping motor **44** of FIG. **3** as a drive source for the thermal activation platen roller **43**, a thermal activation unit drive circuit **45** for driving the thermal-activation thermal head **42** (heater element **41**) and the fifth stepping motor **44**, an unillustrated transmission mechanism for transmitting a torque of the fifth stepping motor **44** to the thermal activation platen roller **43**, and the like.

The thermal-activation thermal head **42** has the same structure as those of thermal heads used as printing heads for known thermal printers. That is, a protective layer made of crystallized glass is formed on the surface of each of plural heater elements (heating resistor elements) formed on a ceramic substrate by using a thin-film or thick-film formation technique. The use of the printing thermal head as the thermal-activation thermal head **42** thus enables a cost reduction. Note that the heater elements **41** of the thermal-activation thermal head **42** do not need to take a divided form on a dot basis as in the heater elements in the printing thermal head but may constitute continuous resistor elements.

In the thermal activation unit **40** thus structured, once the fifth stepping motor **44** is driven according to a drive signal output from the thermal activation unit drive circuit **45** in response to an instruction from the CPU **70** of FIG. **3**, the thermal activation platen roller **43** of FIG. **1** starts rotating counterclockwise. Along with the rotation, the heat-sensitive adhesive sheet A that has passed through the cutter unit **110** is drawn in between the thermal-activation thermal head **42** and the thermal activation platen roller **43** and is fed toward the discharge roller **50** side while its heat-sensitive adhesive layer comes into pressure contact with the heater element **41**. At the same time, the thermal-activation thermal head **42** (heater element **41**) starts thermal activation (heating) in accordance with a drive signal output from the thermal activation unit drive circuit **45** to thereby heat and thermally activate the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet A.

The thermal activation unit **40** desirably includes pressure means for pressing the thermal-activation thermal head **42** against the thermal activation platen roller **43**, such as a coil spring or a plate spring, and adjusting means for adjusting a pressing force of the pressure means. The rotation axis of the thermal activation platen roller **43** is desirably kept in parallel to an arrangement direction of the heater elements **41** with a view to uniformly pressing the heat-sensitive adhesive layer over the width direction against the thermal-activation thermal head **42** (heater element **41**).

The discharge roller **50** of FIG. **1** is composed of an upper discharge roller **51** (rotating roller) placed on an upper side across a transport path for the heat-sensitive adhesive sheet A and a lower discharge roller **52** (rotated roller) placed on a lower side across the same. The upper discharge roller **51** is connected to a sixth stepping motor **54** via an unillustrated transmission mechanism, the stepping motor being controlled by the CPU **70** through a discharge roller drive circuit **53** of FIG. **3**. On the other hand, the lower discharge roller **52** is mounted rotatably about a rotation axis. Once the sixth stepping motor **54** is driven according to a drive signal output from the discharge roller drive circuit **53** in response to an instruction from the CPU **70** of FIG. **3**, the upper discharge roller **51** of FIG. **1** starts rotating counterclockwise. Along with the rotation, the heat-sensitive adhesive sheet A whose heat-sensitive adhesive layer is thermally activated by the thermal activation unit **40** is drawn in between the upper discharge roller **51** and the lower discharge roller **52** and discharged to the outside through the discharge port **2**. At this point, the lower discharge roller **52** is rotated along with the movement of the heat-sensitive adhesive sheet A while bringing the heat-sensitive adhesive sheet A into pressure contact with the upper discharge roller **51**. Of course, the lower discharge roller **52** may be connected to the sixth stepping motor **54** to serve as a rotating roller, whereas the upper discharge roller **51** may serve as a rotated roller.

An explanation has been so far given separately on a relationship among the CPU **70**, the drawing roller **20**, the cutter unit **110**, the thermal activation unit **40**, and the discharge roller **50** for simplicity of explanation. However, in practice, the CPU **70** as overall controlling means controls the drawing roller **20**, the cutter unit **110**, the thermal activation unit **40**, the discharge roller **50**, etc. in parallel. For example, an overall throughput improves in the case where a cutting operation with the cutter unit **110** and a thermal activation operation with the thermal activation unit **40** are concurrently carried out rather than the case where the thermal activation operation with the thermal activation unit **40** is conducted after the cutting operation with the cutter unit **110** is completely finished. However, when the heat-sensitive adhesive sheet A is cut by the cutter unit **110**, the transport of the heat-sensitive adhesive sheet A should be temporarily suspended. Meanwhile, suspending the transport of the heat-sensitive adhesive sheet A during the thermal activation with the thermal activation unit **40** causes a problem in that the heat-sensitive adhesive layer thermally activated sticks to the thermal-activation thermal head **42**, and the like. To that end, the CPU **70** controls the drawing roller **20** and the thermal activation platen roller **43** so as to temporarily sag the heat-sensitive adhesive sheet A between the cutter unit **110** and the thermal activation unit **40**. More specifically, a transport rate of the drawing roller **20** is set higher than that of the thermal activation platen roller **43** or a drive start timing of the thermal activation platen roller **43** is set with a predetermined delay from a transport start timing of the drawing roller **20**. As a result, the heat-sensitive adhesive sheet A is made to temporarily sag. The sheet is cut while the drawing roller **20** comes to a standstill and a sagging portion of the heat-sensitive adhesive sheet A is thermally activated. Thus, the heat-sensitive adhesive sheet A can be cut without bringing the thermal activation platen roller **43** to a standstill (without suspending the thermal activation).

In light of the above, it is necessary for the heat-sensitive adhesive sheet A to sag by a length not smaller than the sum of a length L**1** (mm) of the heat-sensitive adhesive sheet A by which the thermal activation platen roller **43** transports the sheet during a cutting time Tc necessary for the cutter unit **110** to cut the heat-sensitive adhesive sheet A, and a distance Lh (mm) between the cutter unit **40** and the thermal-activation thermal head **42**. Accordingly, the CPU **70** controls the transport rates, operation timings, and the like of the drawing roller **20** and the thermal activation platen roller **43** through the drawing roller drive circuit **23** and the thermal activation unit drive circuit **45** of FIG. **3** so as to sag the sheet by a length not smaller than the sum of L1+Lh (mm).

Further, for improving the throughput in a usage form as shown in FIG. **1**, that is, in a usage form where the heat-sensitive adhesive sheet A whose printable layer undergoes printing with the printer P**2** is immediately fed to the thermal activation apparatus P**1** and thermally activated, it is desirable to aim at total optimization factoring in the length of the heat-sensitive adhesive sheet A, the distance between the printing thermal head **92** and the thermal-activation thermal head **42**, the distance between the cutter unit **40** and the thermal-activation thermal head **42**, a printing rate (=transport rate of the printing platen roller **93**), an activation rate (=transport rate of the thermal activation platen roller **43**), a drive start timing of the thermal-activation thermal head **42** (heater element **41**), and the like.

Here, an elapsed time after the insertion detection signal is input is given as one parameter for defining a timing at which the CPU **70** activates the thermal-activation thermal head **42** (heater element **41**). For example, the printing rate, the activation rate, and a time period from the insertion detection with the insertion detecting sensor **10** till the activation of the thermal-activation thermal head **42** (heater element **41**) are preset. In this case, the CPU **70** measures the elapsed time from the input of the insertion detection signal and issues an instruction to the thermal activation unit drive circuit **45** after the elapse of the preset time, thereby activating the thermal-activation thermal head **42** (heater element. **41**). The elapsed time from the input of the insertion detection signal can be used as a parameter except the parameter for defining the timing for activating the thermal-activation thermal head **42** (heater element **41**). For example, it is also possible to activate the drawing roller under the condition that the predetermined time elapses after the insertion detection signal is input.

A sensor similar to the insertion detecting sensor **10** can be also placed in front of the discharge port **2** of the casing **3** to thereby control the thermal activation unit **40** so as not to start the next thermal activation operation until the sensor cannot detect the heat-sensitive adhesive sheet A anymore. In other words, provided that the sensor is placed immediately in front of the discharge port **2**, the leading edge of the heat-sensitive adhesive sheet A that has passed through the thermal activation unit **40** is detected by the sensor and a detection signal output from the sensor is input to the CPU **70**. After that, once a trailing edge of the heat-sensitive adhesive sheet A passes through the sensor (the heat-sensitive adhesive sheet A is wholly discharged through the discharge port **2**), the input of the detection signal comes to an end. Accordingly, if the thermal activation unit **40** is allowed to conduct the next thermal activation operation after the input of the detection signal comes to an end, the heat-sensitive adhesive sheet A is not jammed.

In the thermal activation apparatus P**1** of FIG. **1**, the drive systems for the drawing roller **20**, the thermal activation unit **40**, and the discharge roller **50** each have the stepping motor. However, if two or more of the drive systems share one stepping motor, the drive systems can be simplified. In this case, functions of the drawing roller drive circuit **23** and the discharge roller drive circuit **53** of FIG. **3** are integrated and assigned to a single motor drive circuit, which enables the simple control system as well. Further, functions concerning the drive of the stepping motor out of the functions of the thermal activation unit are integrated and assigned to the above motor drive circuit, which affords a simpler structure. The drive source for each drive system may be also a DC motor or such other motor except the above stepping motor. It is also possible to allow a two-way or one-way communication with the printer and operate the above components under the control of the printer.

It is also possible to provide the insertion port **1** of the thermal activation apparatus P**1** of FIG. **1** with any receiving means such as a plate member capable of guiding to the insertion port **1** the printed heat-sensitive adhesive sheet A discharged through the printer discharge port **81** of the printer P**2**.

In a printer having a structure in which a printing operation is carried out while any transporting means transports a sheet material, a signal (sheet feeding pitch signal) is generally output each time the sheet material is transported at a predetermined pitch or by a predetermined length. For example, in the printer P2 of FIG. **1**, the drive signal output to the second stepping motor **94** from the printing unit drive circuit **95** of FIG. **2** corresponds to the above sheet feeding pitch signal. Also, if any other signals are output in synchronization with the drive signal, the signals are regarded as being equivalent to the sheet feeding pitch signal. Thus, the thermal activation apparatus of the present invention also includes a thermal activation apparatus where means for receiving the above sheet feeding pitch signal from the printer, and means for inputting the received sheet feeding pitch signal to the controlling means are provided to effect control by making use of the sheet feeding pitch signal. An example of the control based on the sheet feeding pitch signal will be explained in detail taking as an example the printer P**2** and the thermal activation apparatus P**1** of FIG. **1**. To perform the aforementioned control, the thermal activation apparatus P**1** includes means for taking out a sheet feeding pitch signal output from the printing unit **90** of the printer P**2** with a hardware process and means for inputting the received signal to the CPU **70** of FIG. **3**. When the sheet feeding pitch signals input to the CPU **70** are counted up to a predetermined number or larger, the CPU **70** issues an instruction to the thermal activation unit drive circuit **45** to activate the thermal-activation thermal head **42**. After the input of the sheet feeding pitch signal to the CPU **70** comes to a standstill, the cutter unit **110** is activated to cut the heat-sensitive adhesive sheet A. Further, the thermal activation platen roller **43** is driven in synchronization with the sheet feeding pitch signal. In this case, on account of a given distance between the printing unit **90** and the thermal activation unit **40**, the input of the sheet feeding pitch signal comes to a standstill while the thermal activation unit **40** is driven. After the input of the sheet feeding pitch signal comes to a standstill, the CPU **70** autonomously keeps on driving the thermal activation unit **40** until the completion of the thermal activation of the heat-sensitive adhesive sheet A.

In the case where the printer has means for transmitting the sheet feeding pitch signal to the outside, the foregoing control or operation can be also attained by providing means for receiving the sheet feeding pitch signal transmitted from the printer and means for inputting to the CPU the received sheet feeding pitch signal.

An explanation will be made of an example of appropriate control from the view point of maximizing a throughput in a series of operations from printing to the thermal activation as much as possible while using the printer P2 and the thermal activation apparatus P**1** of FIG. **1** by way of example. The thermal activation apparatus P**1** is provided with communication means for acquiring information on the following items (1) to (6) or the information on the following items (1) to (6) is preset in the thermal activation apparatus P**1**.

(1) A length of the heat-sensitive adhesive-sheet A: L (mm)
(2) A printing rate of the printing unit **90** (transport rate of the printing platen roller **93**): Vp (mm/sec)
(3) A distance between the printing unit **90** and the cutter unit **110**: Lp (mm)
(4) A distance between the cutter unit **90** and the thermal activation unit **40**: Lh (mm)
(5) A thermal activation rate of the thermal activation unit (transport rate of the thermal activation platen roller **43**): Vh (mm/sec)
(6) A cutting time with the cutter unit **110**: Tc (sec)

The CPU **70** of the thermal activation apparatus P**1**, which stores the information on the above items (1) to (6), calculates a time Tw (sec) from when the printing unit **90** starts the printing operation till when the thermal activation unit **40** starts the thermal activation operation based on the following expression:

$$Tw=(L+Lp)/Vp-(L-Lh)/Vh+Tc$$

Further, the CPU **70** calculates a time Tt (sec) necessary for the leading edge of the heat-sensitive adhesive sheet A that has undergone printing with the printing unit **90** to reach the thermal activation unit **40** based on the following expression:

$$Tt=(Lp+Lh)/Vp$$

The CPU **70** compares the calculations from the two expressions and, if a relationship of $Tw \geqq Tt$ is established, allows the thermal activation unit **40** to start the thermal activation operation after the elapse of the time Tw from when the printing unit **90** starts the printing operation. In contrast, if a relationship of $Tw<Tt$ is established, the CPU allows the thermal activation unit **40** to start the thermal activation operation at a point in time when the leading edge of the heat-sensitive adhesive sheet A reaches the thermal activation unit **40**. By defining the thermal-activation start timing of the thermal activation unit **40** in this way, it is possible to activate the cutter unit **110** at the time when the trailing edge of the heat-sensitive adhesive sheet A that has undergone printing with the printing unit **90** reaches the cutter unit **110**.

Assuming that the information on the above items (1) to (6) and other information are acquired through the two-way or one-way communication with the printer P**2**, the thermal activation apparatus P**1** is preferably provided with a communication connector which is automatically connected to a communication connector provided in the printer P**2** once being mounted to the printer P**2**.

The thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention includes an insertion port through which the heat-sensitive adhesive sheet including a sheet-like base material is inserted with the sheet-like base material having a printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface, a first transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port, a second transporting means for receiving the heat-sensitive adhesive sheet from the first transporting means and transporting the heat-sensitive adhesive sheet, thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the second transporting means, cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length, which is placed between the first transporting means and the second transporting means, a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged, and controlling means for controlling the first transporting means and the second transporting means such that the heat-sensitive adhesive sheet temporarily sags between the cutting means and the thermal activation means.

(1) It is therefore possible to thermally activate the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet printed by a separately provided printer as needed. Also, it is possible to thermally activate the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet in

advance and then effect printing on the printable layer with any printing means or writing on the same by hand. Further, the heat-sensitive adhesive sheet can be first put on the object, followed by printing on the printable layer or writing on the same by hand.

(2) It is therefore possible to receive the printed heat-sensitive adhesive sheet discharged from the printer capable of printing on the printable layer of the heat-sensitive adhesive sheet in succession or as required and thermally activate the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet.

(3) It is therefore possible to adopt a usage form where a single apparatus enables both the thermal activation operation and cutting operation of the heat-sensitive adhesive sheet, with which a long sheet on which the same pattern is repeatedly printed or continuous patterns are printed is cut to a required length to thermally activate only the cut portion.

(4) It is therefore possible to perform cutting with the cutting means while the heat-sensitive adhesive sheet is transported by the second transporting means, whereby a throughput improves.

In the case of providing controlling means for controlling the cutting means to cut the heat-sensitive adhesive sheet after a length of the sagging sheet is equal to or larger than a predetermined length, the thermal activation operation and the cutting operation can be concurrently conducted on the heat-sensitive adhesive sheet, whereby the throughput further improves in its entirety.

In the case of providing insertion detecting means for detecting the heat-sensitive adhesive sheet inserted through the insertion port and controlling means for controlling the thermal activation means to start the thermal activation operation after a predetermined time elapses from when the insertion detecting means detects the heat-sensitive adhesive sheet, a thermal-activation start timing can be easily and reliably controlled.

The thermal activation apparatus for a heat-sensitive adhesive sheet according to another aspect of the present invention includes an insertion port through which a printed heat-sensitive adhesive sheet is inserted after being discharged from a printer for effecting printing on a printable layer of the heat-sensitive adhesive sheet including a sheet-like base material having the printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface, transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port, thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the transporting means, a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged, and controlling means for controlling at least one of the transporting means and the thermal activation means according to sheet feeding pitch signals output from the printer.

(1) It is therefore possible to perform the thermal activation operation in synchronization with the sheet feeding pitch of the printer to eliminate the need for setting a thermal activation rate on the thermal activation apparatus side.

(2) It is therefore possible to control the thermal-activation start timing of the thermal activation means and the cutting timing of the cutting means according to the sheet feeding pitch signals to simplify the control system in the thermal activation apparatus.

(3) If the sheet feeding pitch signals are taken out from the printer through a hardware process, effects of (1) and (2) above can be obtained with no change of software of the printer.

The thermal activation apparatus for a heat-sensitive adhesive sheet according to the present invention further includes cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length, and controlling means for calculating a time Tw from when the printer starts a printing operation till when the thermal activation means starts a thermal activation operation and a time Tt necessary for a leading edge of the heat-sensitive adhesive sheet printed by the printer to reach the thermal activation means and, when a relationship of $Tw \geqq Tt$ is established, allowing the thermal activation means to start the thermal activation operation after the elapse of the time Tw from when the printer starts the printing operation and, when a relationship of $Tw < Tt$ is established, allowing the thermal activation means to start the thermal activation operation at a point in time when the leading edge of the heat-sensitive adhesive sheet reaches the thermal activation means. Consequently, the time lag between the end of the printing operation in the printer and the start of the cutting operation is reduced as much as possible to thereby considerably improve the total throughput of the operations from the cutting operation to the thermal.

What is claimed is:

1. A thermal activation apparatus for a heat-sensitive adhesive sheet, comprising:

an insertion port through which is inserted a heat-sensitive adhesive sheet including a sheet-like base material having a printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface;

first transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port;

second transporting means for receiving the heat-sensitive adhesive sheet from the first transporting means and transporting the heat-sensitive adhesive sheet;

cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length, which is placed between the first transporting means and the second transporting means;

thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the second transporting means;

a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged; and

controlling means for controlling the first transporting means and the second transporting means such that the heat-sensitive adhesive sheet temporarily sags between the cutting means and the thermal activation means and for controlling the cutting means to cut the heat-sensitive adhesive sheet after a length of the sagging sheet is equal to or larger than a length corresponding to a sum of a length of the heat-sensitive adhesive sheet transported by the second transporting means within a cutting time of the cutting means and a distance between the cutting means and the thermal activation means.

2. The thermal activation apparatus for a heat-sensitive adhesive sheet as claimed in claim **1**, further comprising

insertion detecting means for detecting the heat-sensitive adhesive sheet inserted through the insertion port; and wherein the controlling means controls the thermal activation means to start a thermal activation operation after a predetermined time elapses from when the insertion detecting means detects the heat-sensitive adhesive sheet.

3. The thermal activation apparatus for a heat-sensitive adhesive sheet as claimed in claim **1**, further comprising

discharge detecting means for detecting the heat-sensitive adhesive sheet discharged through the discharge port; and

wherein the controlling means controls the thermal activation means not to perform a thermal activation operation while the discharge detecting means detects the heat-sensitive adhesive sheet.

4. A thermal activation apparatus for a heat-sensitive adhesive sheet, comprising:

an insertion port through which is inserted a printed heat-sensitive adhesive sheet after being discharged from a printer for effecting printing on a printable layer of the heat-sensitive adhesive sheet which includes a sheet-like base material having the printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface;

transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port;

thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the transporting means;

a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged; and

controlling means for controlling at least one of the transporting means and the thermal activation means according to sheet feeding pitch signals output from the printer.

5. The thermal activation apparatus for a heat-sensitive adhesive sheet as claimed in claim **4**, wherein the controlling means controls the transporting means such that a transport rate is synchronous with the sheet feeding pitch signals while the sheet feeding pitch signals output from the printer are input.

6. The thermal activation apparatus for a heat-sensitive adhesive sheet as claimed in claim **4**, further comprising

insertion detecting means for detecting the heat-sensitive adhesive sheet inserted through the insertion port; and

wherein the controlling means controls the thermal activation means to start a thermal activation operation after the sheet feeding pitch signals input after the insertion detecting means detects the heat-sensitive adhesive sheet are counted up to a predetermined number or larger.

7. The thermal activation apparatus for a heat-sensitive adhesive sheet as claimed in claim **4**, further comprising

cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length; and

wherein the controlling means controls the cutting means to cut the heat-sensitive adhesive sheet on completion of the input of the sheet feeding pitch signals.

8. The thermal activation apparatus for a heat-sensitive adhesive sheet according to claim **4**, further comprising

discharge detecting means for detecting the heat-sensitive adhesive sheet discharged through the discharge port; and

wherein the controlling means controls the thermal activation means not to perform a thermal activation operation while the discharge detecting means detects the heat-sensitive adhesive sheet.

9. A thermal activation apparatus for a heat-sensitive adhesive sheet, comprising:

an insertion port through which is inserted a printed heat-sensitive adhesive sheet after being discharged from a printer for effecting printing on a printable layer of the heat-sensitive adhesive sheet which includes a sheet-like base material having the printable layer formed on one surface and a heat-sensitive adhesive layer formed on the other surface;

transporting means for transporting the heat-sensitive adhesive sheet inserted through the insertion port;

thermal activation means for heating and thermally activating the heat-sensitive adhesive layer of the heat-sensitive adhesive sheet transported by the transporting means;

a discharge port through which the heat-sensitive adhesive sheet having the heat-sensitive adhesive layer thermally activated by the thermal activation means is discharged;

cutting means for cutting the heat-sensitive adhesive sheet to a predetermined length; and

controlling means for controlling the thermal activation means based on information transmitted from the printer and for calculating a time Tw from when the printer starts a printing operation till when the thermal activation means starts a thermal activation operation and a time Tt necessary for a leading edge of the heat-sensitive adhesive sheet printed by the printer to reach the thermal activation means and, when a relationship of $Tw \geqq Tt$ is established, allowing the thermal activation means to start the thermal activation operation after the elapse of the time Tw from when the printer starts the printing operation and, when a relationship of $Tw < Tt$ is established, allowing the thermal activation means to start the thermal activation operation at a point in time when the leading edge of the heat-sensitive adhesive sheet reaches the thermal activation means based on both or one of the information transmitted from the printer and preset information.

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